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KIBOWI, a training wargame for the Royal Netherlands Army

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author(s)	: Ir. W.C. Borawitz
institute	: TNO Physics and Electronics Laboratory
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ABSTRACT (UNCLASSIFIED)

A prototype wargaming model for the Royal Netherlands Army is under development at the Physics and Electronics Laboratory TNO of the Netherlands Defence Research Organization. This game will be used to train staff officers at battalion and brigade level. The development of the model is based on the latest available information technology: Ada, VAX/VMS and VAX hardware. The model is dedicated to run realtime on a one minute time step basis on a micro-VAX local area network or a VAX-cluster.

The model uses terrain data partly based on DLMS (Digital Land Mass System), with added terrainfeatures.

It is expected that the model will be ready for use as a prototype by the Royal Netherlands Army by the end of 1989. Experimental use of the model was made during 1988 and 1989 for approximately 20 weeks at the battalion level.

Experience with the use of the prototype during the years 1990 en 1991 will be used to develop the model in its final form to be delivered to the 1st Netherlands Corps and the Training Command in 1992.

The paper will focus on a number of model aspects such as terrain, unit representation and unit interaction (detection, direct fire, etc.).

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auteur(s) : Ir. W.C. Borawitz
instituut : Fysisch en Elektronisch Laboratorium TNO

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SAMENVATTING (ONGERUBRICEERD)

Een prototype wargame model voor de Koninklijke Landmacht is in ontwikkeling op het Fysisch en Elektronisch Laboratorium TNO van de Hoofdgroep Defensie Onderzoek. De wargame zal worden gebruikt voor de training van stafofficieren op bataljons- en brigadeniveau. De ontwikkeling van het model is gebaseerd op de meest recente informatietechnologie: Ada, VAX/VMS en VAX hardware.
Het model is bestemd om realtime op een tijdstapbasis van één minuut te werken op een micro-VAX netwerkconfiguratie of een VAX cluster.
Het model gebruikt terreindata deels gebaseerd op DLMS (Digital Land Mass System), met toegevoegd terreinkenmerken.
De verwachting is dat het model eind 1989 gereed zal zijn om als prototype te worden gebruikt door de Koninklijke Landmacht. Experimenteel gebruik van het model heeft plaatsgevonden gedurende 1988 en 1989 voor circa 20 weken op bataljonsniveau.
Ervaring in het gebruik van het prototype gedurende 1990 en 1991 zal worden verwerkt om het model tot zijn eindvorm te ontwikkelen, dat in 1992 aan het Eerste Legerkorps en het Commando Opleidingen Koninklijke Landmacht wordt overgedragen.

Het rapport concentreert zich op een aantal modelaspecten, zoals terrein, eenheid representatie en eenheidsinteractie (detectie, direct vuur, etc.).

CONTENTS

1 INTRODUCTION

Research at the Physics and Electronics Laboratory (FEL) of the Netherlands organization for applied scientific research (TNO) is focussed on sensor technology, system development, information technology and operations research.
Within the Operations Research division combat simulations and wargames are used since 1963.
The use of wargaming for other purposes than research was first introduced by the wargame SOLTAU in 1981.
The wargame SOLTAU was developed for the Army Staff College to support tactics training at brigade and division level in the higher military education program.
Two basic requirements were fulfilled in SOLTAU: ease of use and concentration on intelligence (S2) and operations (S3).
SOLTAU uses a 100 x 70 km digitized terrain subdivided in 1 km square grid, superposed are natural and artificial obstacles (e.g. rivers and minefields) and unit descriptions are based on weighted unit values (see also ref. [1])
Starting in 1983 more and more use was made of the SOLTAU wargame for research (doctrine development, weapon procurement) and command post exercises.
In 1985 and 1986 a number of command post exercises at battalion, brigade and division player level were successfully supported with the SOLTAU wargame on a set of micro-VAX computers.
In comparison to the traditional Command Post Exercises the following benefits of the computer assistance were established (see also ref. [1]):

1. open ended exercises, exercise scripts and timelines only globally restrict free play;
2. battle actions are represented in a detailed, realistic and consistent way;

3. players and lower control acquire considerable knowledge about organization and doctrine of the opposing party;
4. all exercise data are logged for replay and evaluation and although the computer equipment and wargame use asks for some consideration;
5. computer assistance is possible from battalion up to division player level;
6. exercise locations can be chosen freely, normal military communication systems can be used and player staffs can operate from their command post in the field;
7. computer hardware is transportable to any indoor location and the computer assistance can be fully hidden from player level.

Seeing the benefits, and knowing the SOLTAU deficiencies FEL-TNO was tasked in 1986 to develop a new wargame system (called KIBOWI) to better the SOLTAU wargame, i.e.

1. enhanced terrain resolution;
2. more detailed unit description;
3. more detailed evaluation of direct and indirect fire;
4. introducing the battle support functions;
5. giving more adequate lower control response facilities.

The KIBOWI project will reach the prototype state at the end of the year 1989.
In between SOLTAU is still used, especially for the brigade and division command post exercises of 1 (NL) Corps.
From 1987 onwards KIBOWI is used more and more. First in tests only, and, starting in 1988, in battalion command post exercises and the Training Command officer courses.
In chapter two the paper describes the organizational setting and expected use for KIBOWI in the Netherlands Army.
In chapter 3 the KIBOWI model description is given, chapter 4 deals with the hard and software and chapter 5 and 6 give some of our experiences during tests and our anticipation of future developments for KIBOWI.

2 THE COMPUTER ASSISTED COMMAND POST EXERCISE

For a good understanding of the function of a wargame system to support a command post exercise the following section will shortly summarize the organizational setting (see figure 1).
The command Post Exercise is a type of exercise meant to train a staff called player level in its command post in a simulated war environment. In order to reach the exercise goals the exercise control unit is coordinating the exercise by direct contact with all the control participants (enemy included).
The player staffs are linked to their own operational commanders and command their own units (lower-control). Depending on the exercise set-up, the player staffs can be in the field in their own tactical deployed command posts or in another location. When not operating from tactical deployed command posts, communications should be as real as possible.
Higher control commands the player staff and must perform functions such as engineer or artillery in support of the player directly into the wargame. Higher control does not control the enemy players, but does control the tactical actions of the player and as such is responsible for a large part of the exercise goal(s).
Flank control fills the information gaps left by higher control to give both enemy players and player staff(s) a complete battle picture.
The enemy players are traditionally fighting the battle according to some basic settings made prior to the exercise to make the exercise successfull.
The monitor control is introduced to sort out or redirect situations due to wargame shortcomings and control unit errors. One important task is to inform both higher and exercise control of tactical situations prior to their "discovery" by lower control, player staff(s) and higher control. This task when neglected will make exercise control impossible due to the large number of imperfect interpretations and long delay times from lower control through player staff(s) to higher control.
Lower control is a crucial function to be performed in the computer assisted CPX. Lower control has the following tasks: to order his units

in the wargame, to interpret wargame messages, translate these to tactical information and then send this to his commander in the appropriate way. The purpose is to make his commander believe he is in actual battle (and not playing a game with the computer).
The technical assistance is tasked to run the wargame on a set of computer systems, to provide the control-units access to the wargame (input and output) and to assist where necessary to sort out technical or wargame problems.

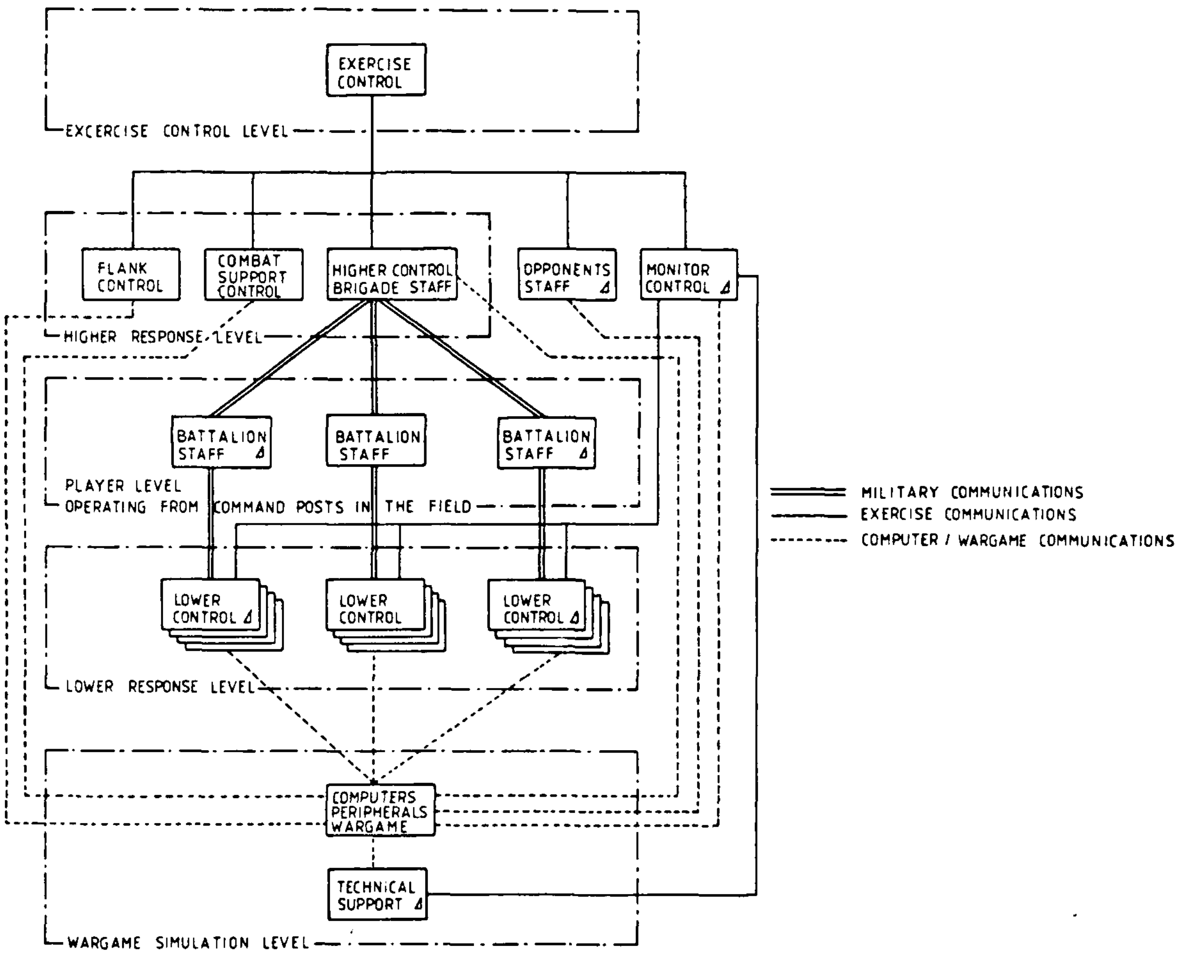

Fig. 1: Organization for computer assisted command post exercise at battalion (player) level

The basic organization for large scale exercises does not differ much from small exercises. The larger scale spreads the functions over a wider area and communications will accordingly be over longer distances.

As far as computer assistance is concerned, the number of computer connections will be larger and more attention must be paid to the system reliability (back-up procedures and systems) and security regulations. Starting this year all command posts exercises by the 1 (NL) Corps of battalion and higher livel will be computer assisted.
The wargame SOLTAU will be used for the brigade and division level till KIBOWI is capable of doing this (brigade level expected in '90, division level expected in '92).
The command post exercises last in principle one week on a 24 hours per day basis. The exercise location can be chosen freely, as the complete system is mobile.
One permanent facility has been built (see figure 2) at Stroe-barracks, capable of supporting brigade sized exercises with a maximum of four battalion player staffs together with one brigade staff to be trained. When operating on a 24 hour basis 250 controls, of which 150 lower controls (company commanders, their seconds in command and the artillery observers) are needed.

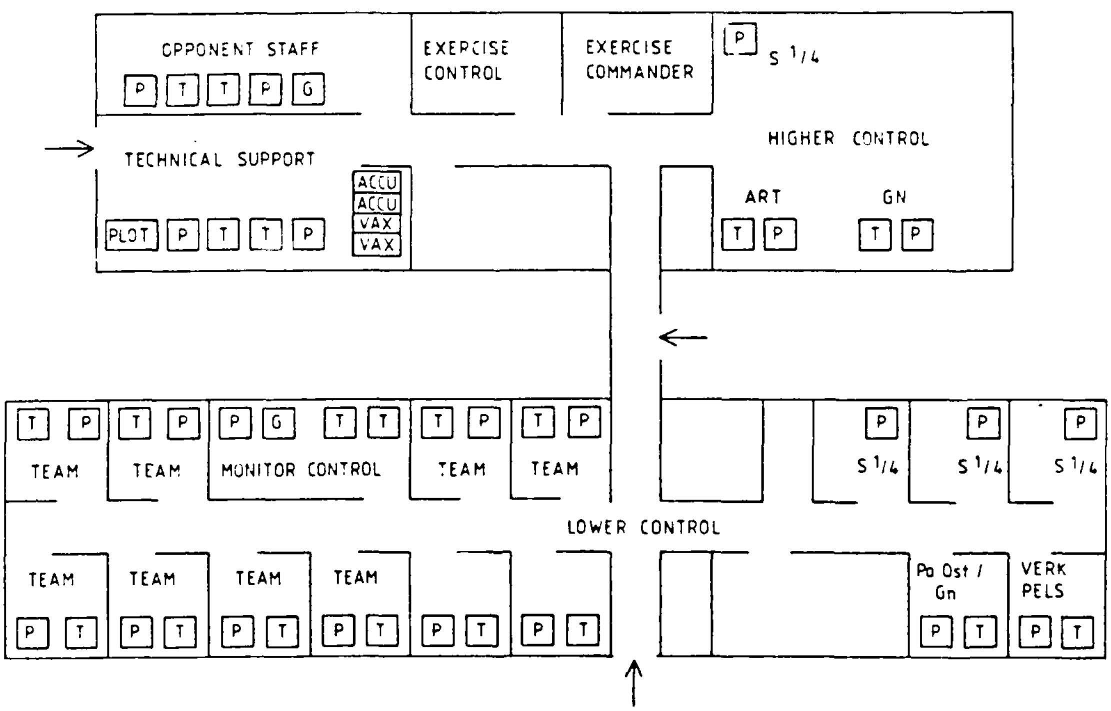

Fig. 2: Stroe barracks wargame facility

Apart from the use · the 1 (NL) Corps, KIBOWI is to support courses for company commanders, battalion staff officers and battalion commanders at the Training Command, for which a wargame facility is available at the Infantry Training Centre. For a course setting the control functions are to be combined.
The Army Staff itself is already using the KIBOWI system for study purposes (weapon procurement planning and doctrine development).
The National Sector (territorial brigades), the Army Staff College, the Royal Military Academy and the Royal Marines (UK/NL amphibious brigade) foresee the use of the KIBOWI system.

3 THE KIBOWI WARGAME MODEL

KIBOWI simulates the all-arms battle realtime and in great detail.
The basis for the simulation is the representation of the combat environment: terrain, weather, daytime, roads, bridges, water obstacles, etc. Combat units and supporting units alike are specific combinations of materiel (e.g. tanks, armoured combat vehicles), personnel (e.g. driver, commander, infantry fighting man) and stocks (ammunition, fuel).
KIBOWI handles the interactions between units (sighting, fire exchange), between units and terrain (mobility) and between units and other objects within the terrain (blowing a bridge).
KIBOWI is similar to most existing models, new is the terrain and combat environment description, the simplicity and power of the detection model, the calibration factors, the priority rules for direct fire and the monitor control order set.

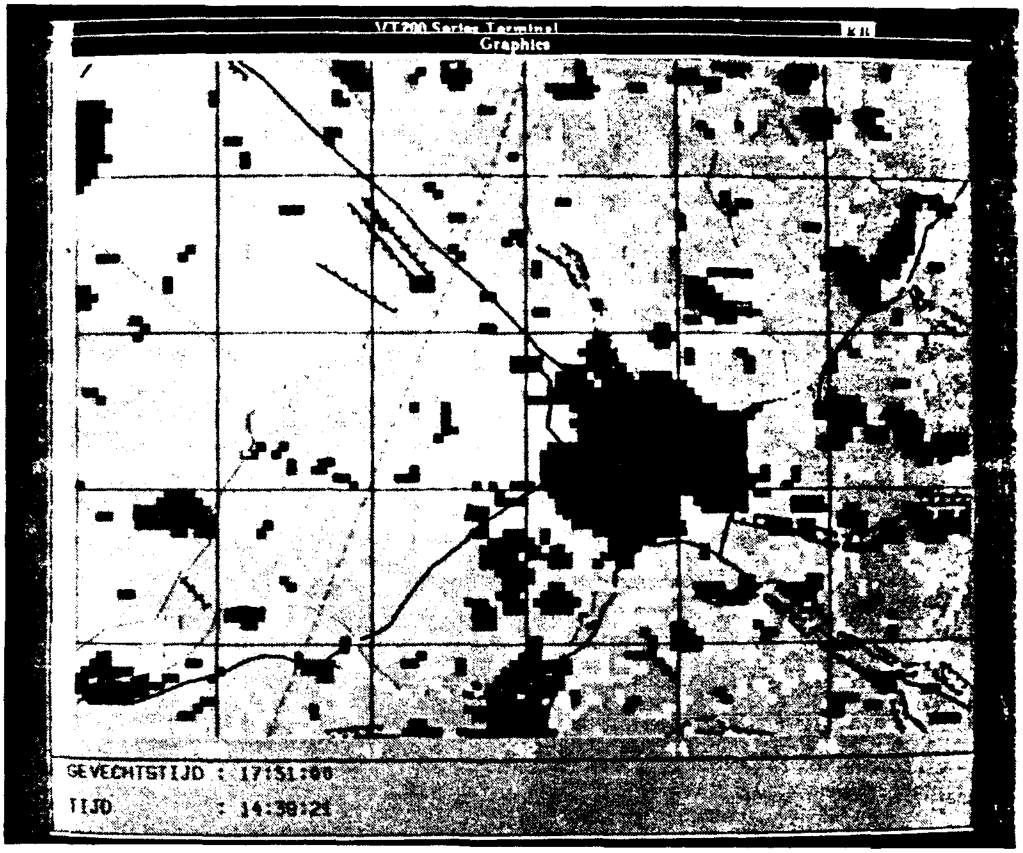

Fig. 3: Combat Environment (photograph from color graphics screen)

3.1 Combat environment

Terrain is represented by a raster of 100 x 100 meters square grids, containing terrain feature, height of terrain feature, terrain elevation (to determine line of sight) and cross country movement category (to determine speed of movement).

Superimposed on this raster are linear objects (e.g. rivers, slopes and minefields) and point objects (e.g. bridges), determining movement constraints and opportunities.

Currently three, each covering an operating area of approximately 60 x 40 km, terrain databases are available in West-Germany and the

Netherlands. Only a part of the data contained in the database relies on Digital Land Mass System formatted data (terrain elevation, terrain feature category and height). The additional data was collected by the 1 (NL) Corps.

Dynamic features of the combat environment include the weather (influencing the cross country movement and the detection ranges), the daytime, smoke screens and contaminated areas. The last two features are not yet implemented.

3.2 Unit representation

Units (usually at platoon or company level) are subdivided into 8 main categories and 37 subcategories ranging from infantry to engineer units. Unit combinations can be referenced through a hierarchy. A single unit will consist of vehicles (armed with weapon systems, ammunition, fuel and crew and with supporting sighting systems) personnel and stocks. Currently a database is used comprising 89 different vehicle types (ranging from tanks Leopard II, T-80 to single jeeps). With this database all current fielded NATO and WP force structures can be modelled.
Fatigue, morale and training level are affecting combat. In KIBOWI the data fields are already set to incorporate these aspects, current complexity of the game precludes their present use.

3.3 Detection

During every evaluation time-step calculations are made to determine if units really "see each other". After checking for line of sight (based on the 100 x 100 meters grid terrain description), a factor ruled detection function is used to decide if a detection takes place. The factors represent the influence of: is the enemy unit detected in previous timeframe, distance between observing and enemy unit, weather, enemy unit status, enemy unit environment (concealment, camouflage), daytime, observing unit status and means of detection.

The factors are multiplied with two preset standard values and determine the minimum detection distance (dmin) and the maximum detection distance (dmax).

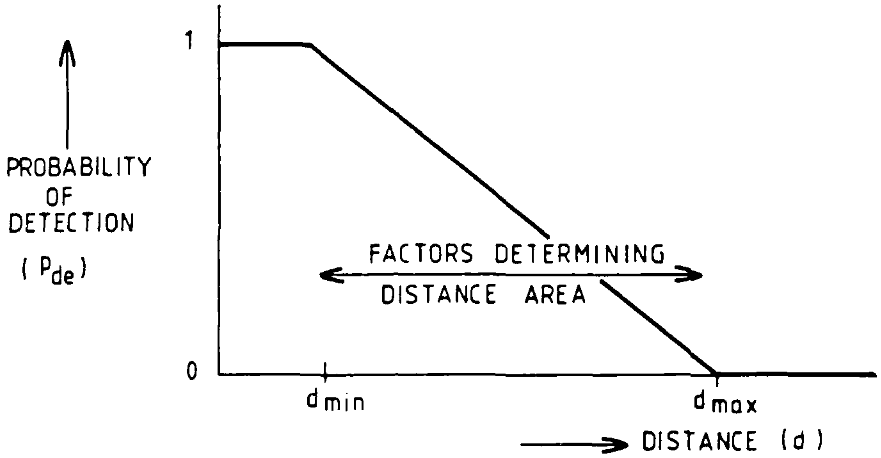

Fig. 4: Detection probability function

E.g. in clear weather dmin could be 500 meters, dmax 4500 meters, meaning assured detection for all distances below 500 meters, no detection possible above 4500 meters.
Between 500 and 4500 a random draw using the detection probability function shown in figure 4 will decide for detection to occur.

3.4 Direct fire

After detection has taken place, and having the unit ready and capable (ammunition availability) of firing, a sequence of calculations is made to:

1. Determine which unit (within sight) and which vehicle type to attack using priority rules from the database or at the choice of the unit itself by deliberate aiming.
   The priority rules allow for alternating the chosen target types by giving correlated weighting values to the target types in the priority list (the number of targets is multiplied by its weighting factor so as to determine target priority in the current fire exchange).

2. Determine the number of rounds using the weapon system database and the current dynamic data of the firing unit (status, etc.).
3. Determine the number of kills made using the dynamic data of both enemy unit and firing unit.

In the second and third calculation the weapon system data are used together with so called calibration factors. The calibration factors are set at the discretion of the army, simulating the battle stress inefficiency of early firing and having a large number of misses, and alternating battle tempos (short engagement period followed by a readjustment, recuperation period).

3.5 Indirect fire

Indirect fire is possible by artillery, mortar and rocket systems. Through the weaponsystem database, the calibre, the ammunition round type and the firing sequence times are known for the indirect fire unit. Depending on the unit status, indirect fire can be ordered by an indirect fire lower control giving ammunition type, number of rounds and target location.
KIBOWI then:

1. calculates the time (deterministic) and place (stochastic) of impact,
2. sorts out units in the rectangular damage area, and
3. uses vulnerability data from the database to determine losses (stochastic) for weapons, ammunition and personnel.

The size of the rectangular damage area depends on the calibre and the firing unit level (e.g. platoon, battery, or battalion fire).

3.6 Movement

Every time step the movement vectors of the units are determined, adjusted for cross country movement, road movement and unit status. Vectors intersecting obstacles are treated seperately, checking for instance (for a water-obstacle) whether a bridge is available within 100

meters of the intersection of the movement vector and the water-obstacle. If no such bridge is available it is checked whether the unit could cross it independently (taking time to prepare for a river crossing operation).
For a minefield checks are made if lanes are available, and if not whether the units could breach it.
All linear and point terrain obstacles are referenced through a net structure (1 x 1 km) giving the movement algorithm only a limited number of obstacles to consider.

3.7 Logistics

Supply and resupply of ammunition and fuel are modelled by having supplies of ammunition and fuel ordered and moved through the area by units (either logistic units or manoeuver units). These units are checked for vehicle loading capacities, loading facilities and loading times.
Ammunition and fuel consumption is controlled by the direct fire, indirect fire, air defence, air support and movement processes.
Resupply or recovery of weapon systems and troops can be ordered from outside the game by monitor control.

3.8 Engineer operations

In KIBOWI a number of engineer operations is modelled: making entrenchements for platoon fire positions, bridge construction, and bridge demolition, minefield laying, minefield breaching, making passage ways through obstacles, making road craterings, tankditches, barbed wire obstacles,and wood hackings.

3.9 Helicopter combat

Helicopters are treated as all other units in the game, except for movement.
For movement three modes are available: flying under terrain cover (low speed), contour flying (medium speed) and transit flight (high speed).

Depending on flying altitude the line of sight differs from the ground units.
Helicopters using terrain cover are given first detection benifit over enemy units, losing this benefit if they open fire (at some other unit).

3.10 Air support and Air defence

Air support from fixed wing is modelled by having single aircraft crossing the air above the operating area, release their weapons and backtrack to their staying point outside the arena. Airbase operations are not modelled.
The defence against the air support is possible by the air defence units using their airdefence weapon systems and the units within the vicinity of the release point (having line of sight with the aircraft), using their direct fire weapon systems.

4. THE KIBOWI WARGAME SYSTEM

4.1 Hardware

The KIBOWI system runs on a Local Area VAX-network (using micro VAX systems) or a VAX cluster and can be (and is) operated from any indoor location.
The prototype will consist of at least 2 micro VAX computers, 7 VAX2000 graphics systems, 15 VT320 terminals and 15 printers, one plotter, one colour printer and possibly one video projector.
In the envisaged product version for a full brigade exercise up to 20 VAX2000 systems would be needed.

4.2 Software

KIBOWI has been implemented in ADA. Two supporting packages were developed to seperate the wargame software from the VAX/VMS environment: ATD (Advanced Terminal Driver) and GRAPHICS (GKS graphics binding with ADA).
The KIBOWI software is subdivided into a number of programs running simultaneously on more than one CPU. The major programs are:

1. Operator
   To control all KIBOWI processes, readjusting for hardware failures, making backups, restarts, etc.
2. Database manager
   To create exercise databases and to facilitate and control all database access, either by the evaluator, or one of the server processes.

3. Server
   To connect a set of interfaces to one VAX-CPU in the network.
4. Evaluator
   To evaluate all combat processes and to store situation updates in the dynamic database.
5. User interface
   To give access to combat information in a controlled way (only the information which is known to the lower control subordinate units), transferring orders from lower control to evaluator.

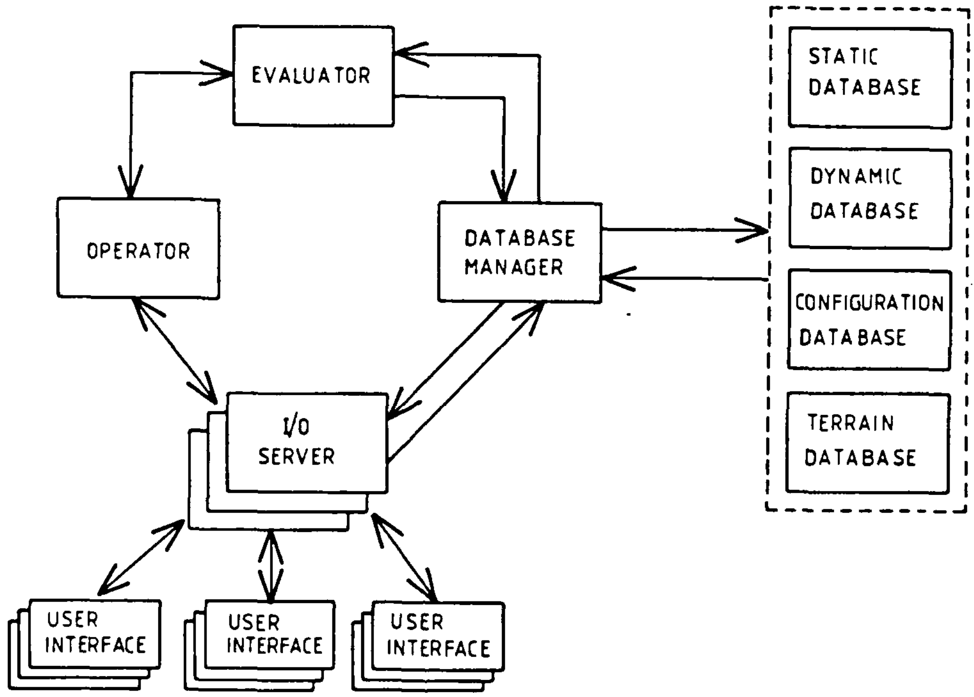

Fig. 5: KIBOWI software

4.3 User interface

The lower control interface of KIBOWI is based on a menu driven orderinput and a color graphics output, optionally available is printer output.

The graphics stations provide real time information about subordinate units as an overlay on the KIBOWI combat environment display, showing movement, detection, direct fire and indirect fire, from the subordinate units point of view. The input terminals are menu driven and provide help functions for desired actions.

As examples of the available functions:

Lower control can inspect platoon positions by making line of sight pictures on the graphics screens during the game.

Units can be ordered to move to a fire position, open fire and retreat in one sequence called the fire raid. The ability to order sequences of single operations enables for lower control to actively fight the battle at company level.

For monitor control and exercise direction, graphics stations are available, combined with color printing and plot facilities.

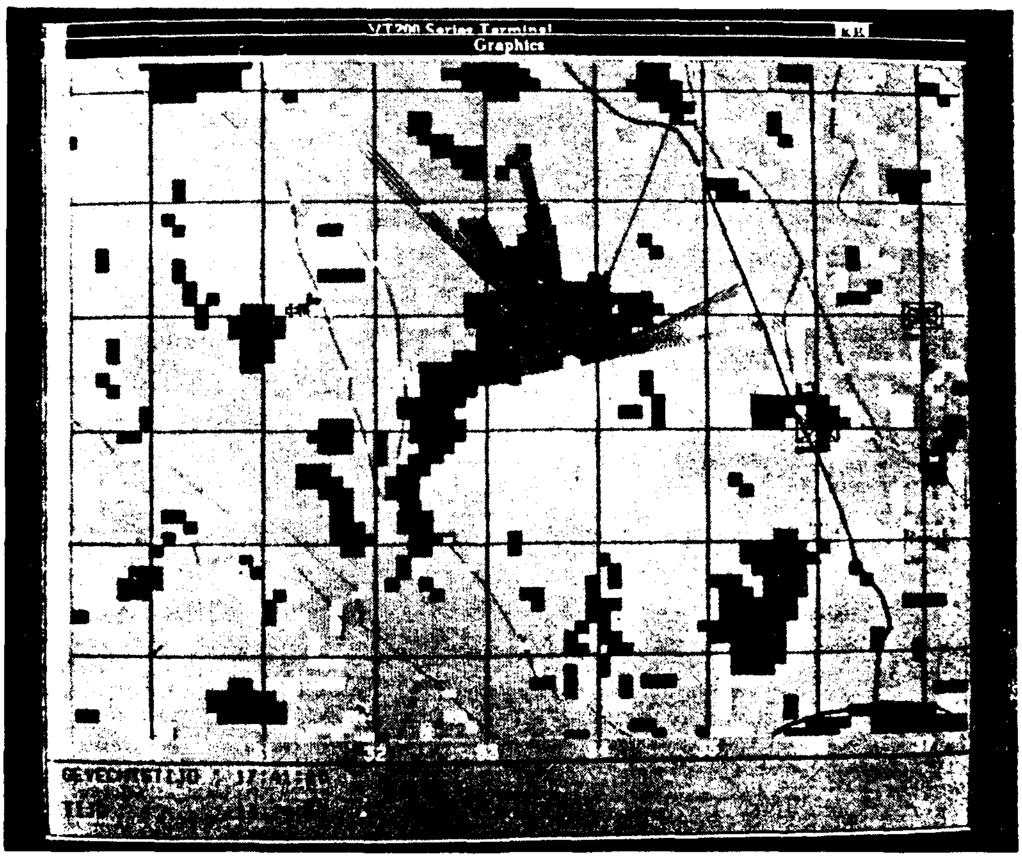

Fig. 6: Line of sight diagram (photograph from color graphics screen)

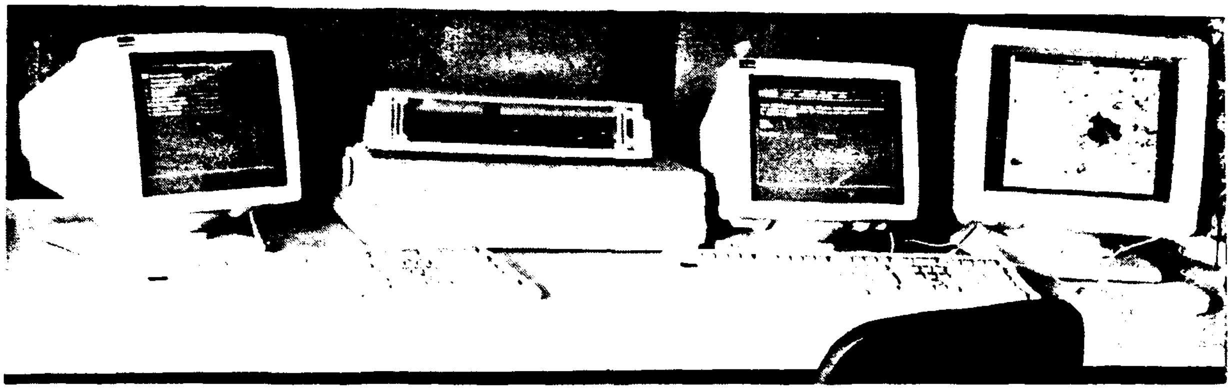

Fig. 7: Lower control hardware

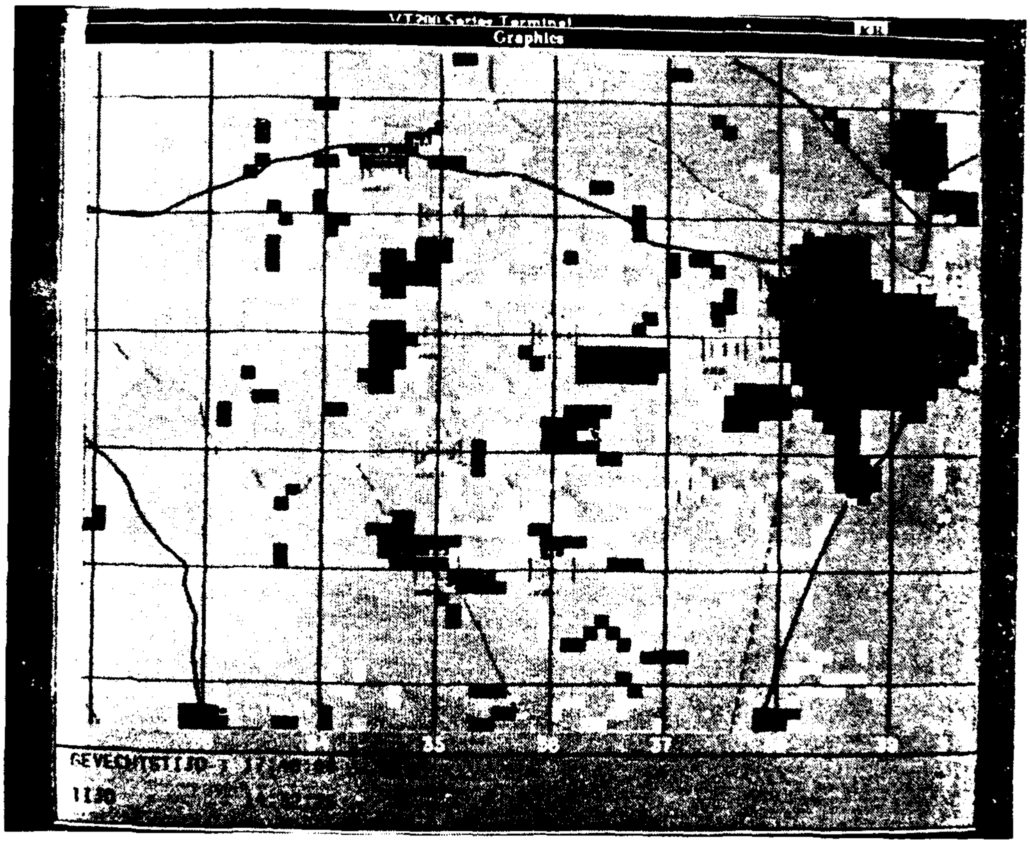

Fig. 8: Combat situation display, photograph from color graphics screen

5 CURRENT TESTS AND USE OF THE KIBOWI PROTOTYPE

Following the rapid development of a laboratory test version of the KIBOWI system, extensive user tests were conducted.
The first tests (1987) were executed at the Physics and Electronics Laboratory using groups of military experts from the different branches.
The tests in 1988 and 1989 were conducted both at the training command (course situation) and with the 1 (NL) Corps (Battalion staff command post excersises). During the tests a number of deficiencies were corrected. The CPU performance of the current micro-VAX'es increasingly proved to be a problem for running real-time.
For the end of this year a brigade command post exercise is scheduled, using a new VAX-system to overcome this performance problem.
The tests also made it clear that KIBOWI owing to its high level of detail is difficult to handle; hence research is spent to further simplify control operations (lower control, monitor control and enemy play).
KIBOWI (as other wargames do) when used for training, stimulates discussions about the crucial factors dictating war and combat operations within it.

6 FUTURE DEVELOPMENTS

After the final test of the prototype at brigade level november this year, the prototype will be delivered to the 1 (NL) Corps and the Training Command to be used during 1990 and 1991 CPX's and courses.
A delivery of two complete KIBOWI systems for the Netherlands Army is scheduled in 1992.
At the Physics and Electronics Laboratory further developments will be concentrated on making KIBOWI capable of supporting division and army corps exercises, and making better evaluation tools.

Ir. M.J. v.d. Scheur	Ir. W.C. Borawitz
(divisiehoofd)	(auteur)

7 REFERENCES

[1] Is it possible to use wargaming techniques in training and adapting them to the tactics of 1 (NL) Corps?
Contribution to the AC/243 (Panel 7) symposium on wargaming 9-11 February 1987, by Ir. W.C. Borawitz and LtCol. L.A.C.M. Coopmans.

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15. ABSTRACT (MAXIMUM 200 WORDS, 1044 POSITIONS)

A PROTOTYPE WARGAMING MODEL FOR THE ROYAL NETHERLANDS ARMY IS UNDER DEVELOPMENT AT THE PHYSICS AND ELECTRONICS LABORATORY TNO OF THE NETHERLANDS DEFENCE RESEARCH ORGANIZATION. THIS GAME WILL BE USED TO TRAIN STAFF OFFICERS AT BATTALION AND BRIGADE LEVEL. THE DEVELOPMENT OF THE MODEL IS BASED ON THE LATEST AVAILABLE INFORMATION TECHNOLOGY: ADA, VAX/VMS AND VAX HARDWARE. THE MODEL IS DEDICATED TO RUN REAL TIME ON A ONE MINUTE TIME STEP BASIS ON A MICRO-VAX LOCAL AREA NETWORK OR A VAX-CLUSTER.
THE MODEL USES TERRAIN DATA PARTLY BASED ON DLMS (DIGITAL LAND MASS SYSTEM), WITH ADDED TERRAINFEATURES.
IT IS EXPECTED THAT THE MODEL WILL BE READY FOR USE AS A PROTOTYPE BY THE ROYAL NETHERLANDS ARMY BY THE END OF 1989. EXPERIMENTAL USE OF THE MODEL WAS MADE DURING 1988 AND 1989 FOR APPROXIMATELY 20 WEEKS AT THE BATTALION LEVEL.

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